Unbinding and preunbinding in binary surfactant solutions(Soft Matter as Structured Materials)

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Unbinding and preunbinding in binary surfactant solutions

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界面活性剤と水の二元系におけるラメラ相の非束縛転移 (unbinding transition) について考察する。Fig. 1 は $C_{16}E_7$ (非イオン性界面活性剤) と水の相図である。ここでは、Milner と Roux の非束縛転移のモデル [1] から出発して、非束縛転移が一次相転移となるようなモデルを提案する。そのために、活性剤の体積分率とネマチック配向秩序パラメータの結合を仮定し、配向秩序が活性剤分子間の引力を誘起するような現象論的なモデルを提案する。この結合の強さに応じて、いくつかの相挙動のパターンがあることがわかった。結合が十分に強いと、非束縛転移は一次相転移となる。その場合にはいわゆる "preunbinding line" が出現し、周期の異なる二種類のラメラ相が共存することが予想される。さらに、ラメラ相とネットワークミセルの共存についても議論する。

Based on the model by Milner and Roux [1], we propose a model for the first-order unbinding transition of lyotropic lamellae in binary surfactant solutions. The phase diagram of the $C_{16}E_7$/water binary system is shown in Fig. 1. The coupling between the surfactant volume fraction and the nematic order parameter is taken into account so that the orientational order enhances the net attractive interaction between the surfactant molecules. Such a coupling effect leads to a phase separation between bound and unbound phases, and the model exhibits a rich phase behavior depending on the coupling strength. When the coupling is strong enough, the unbinding transition becomes first-order. We determine the associated preunbinding line which separates two lamellar phases having different repeat distances. We further discuss the coexistence between the lamellar phase and the network micellar phase. Our results explains the experimentally observed unbinding behavior of the lamellar phases in binary mixtures of nonionic surfactant and water. The obtained phase diagram agrees well with that from the experiment [2].

References

[1] S. T. Milner and D. Roux, J. Phys. (France) I **2** (1992), 1741.

[2] R. Strey, R. Schomäcker, D. Roux, F. Frederic, and U. Olsson, J. Chem. Soc. Faraday Trans. **86** (1990), 2253.

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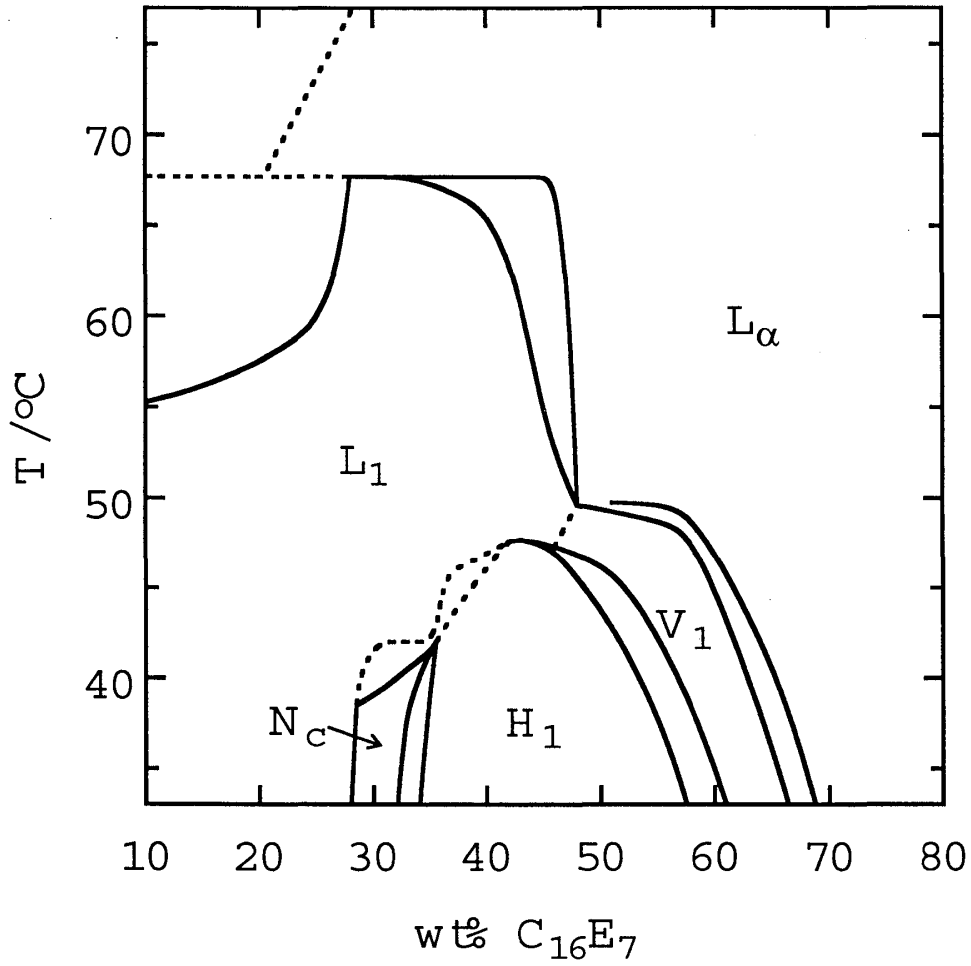

Figure 1: Phase diagram of the $C_{16}E_7$/water system. L_α, lamellar phase; L_1, isotropic micellar phase; L_3, sponge phase; V_1, cubic phase; H_1, hexagonal phase.